

## PASSIVE TRACKING OF DYSKINESIA/TREMOR SYMPTOMS

### TECHNICAL FIELD

**[0001]** This disclosure relates generally to mobile applications and wearable computers for managing chronic disease and helping patients better engage with clinicians.

### BACKGROUND

**[0002]** Parkinson's disease (PD) is a chronic, progressive neurodegenerative disease that affects the nerve cells in the brain that produce dopamine (a neurotransmitter). There are an estimated 600,000 to 1 million cases of PD in the United States and 60,000 new cases are diagnosed each year. Symptoms of PD include depression, anxiety, sleep disorders, bradykinesia, rigidity, balance gait deficits, speech deficits, tremor and dyskinesia. The most common form of tremor is resting tremor. Resting tremor is an unintentional movement that affects a limb when it is at rest and stops for the duration of a voluntary movement. Dyskinesia is an uncontrollable and involuntary movement that can resemble twitching, fidgeting, swaying or bobbing. Dyskinesia tends to occur when other PD symptoms, such as tremor, rigidity and bradykinesia, are well controlled. Dyskinesia typically occurs as a complication of the long-term use of levodopa, the most commonly used medicine to treat PD. Dyskinesia commonly manifests as chorea, a repeated, irregular, jerky motion that rises and falls with medication and is one of the most disabling forms of dyskinesia.

**[0003]** Patients with PD are typically treated using dopamine (e.g., levodopa) replacement therapy to help reduce some of the symptoms of PD. Over time, the dopamine replacement therapy becomes less effective and begins to induce more side effects, such as dyskinesia. A patient's quality of life is largely dependent on how precisely clinicians titrate and schedule the patient's medications to minimize the patient's symptoms. This is a challenge for clinicians because each patient has a different combination of symptoms that can change and become more severe over time. Also, in any given day the symptoms may fluctuate based on medications, food intake, sleep, stress, exercise, etc.

**[0004]** Today's clinical standard for treating PD includes a combination of a patient interview with opportunistic in-clinic observations. Because a patient may be asymptomatic during their visit to the clinic, the clinician often relies on the patient's self-reported symptom tracking outside the clinic. Some patients, however, may have difficulty remembering their symptoms since their last visit to the clinic.

**[0005]** In addition to the patient's self-reported symptoms, clinicians use a gold standard scale called the Movement Disorders Society—Unified Parkinson's Disease Rating Scale (UPDRS). UPDRS is comprised of a series of tasks performed by the patient in the clinic under the observation of the clinician and thus only provides a snapshot in time of the patient's symptoms. The clinician observes the displacement of a limb (e.g., displacement of the patient's wrist) and assigns a tremor score based on the observed displacement of the limb. Based on the score the tremor is labeled as normal, slight, mild, moderate or severe. Because the clinician's observation is coarse and subjective, the clinician may require multiple visits with the patient and adjustments

to their medication schedule before they find one that is effective in managing the patient's symptoms.

### SUMMARY

**[0006]** Embodiments are disclosed for passive tracking of dyskinesia and tremor symptoms using a wearable computer.

**[0007]** In an embodiment, a method comprises: obtaining, by one or more motion sensors of a computer attached to a user's limb, motion data; extracting, by one or more processors of the computer, one or more features from the motion data that are potentially indicative of dyskinesia or tremor; determining, by one or more processors of the computer and based on the one or more extracted features, the likelihood of dyskinesia or tremor; generating, by the one or more processors, data indicating the likelihood of dyskinesia or tremor; and outputting, by the one or more processors, the data through an output device of the computer.

**[0008]** In an embodiment, a system comprises: one or more motion sensors; one or more processors; memory storing instructions that when executed by the one or more processors, cause the one or more processors to perform operations comprising: obtaining, by the one or more motion sensors, motion data; extracting, by the one or more processors, one or more features from the motion data that are potentially indicative of dyskinesia or tremor; determining, by the one or more processors and based on the one or more extracted features, the likelihood of dyskinesia or tremor; and generating, by the one or more processors, data indicating the likelihood of dyskinesia or tremor.

**[0009]** Other embodiments can include an apparatus, computing device and non-transitory, computer-readable storage medium.

**[0010]** One or more of the disclosed embodiments provide one or more of the following advantages: 1) provides all-day symptom/severity tracking information; 2) provides a clinical tool for evaluating patient response to medication; 3) aides the clinician in titrating medication; 4) tracks disease/symptom progression; 5) helps the clinician understand the effect of activity, exercise and sleep on symptoms (contextualization of symptoms); 6) allows patients to better plan activities around symptom patterns; and 7) gives patients and clinicians a more detailed, quantitative, continuous tracking of symptoms than current clinical standards which use questionnaires and UPDRS.

**[0011]** The details of one or more implementations of the subject matter are set forth in the accompanying drawings and the description below. Other features, aspects and advantages of the subject matter will become apparent from the description, the drawings and the claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]** FIG. 1 illustrates a system for passive tracking of dyskinesia/chorea and tremor using a wearable computer, according to an embodiment.

**[0013]** FIG. 2 is a block diagram illustrating data flows for continuous passive tracking of dyskinesia/chorea and tremor using a wearable computer, according to an embodiment.

**[0014]** FIG. 3A is a plot of acceleration readings output by an accelerometer of a wearable computer, according to an embodiment.